Sample statistic: a sample characteristic such as a sample mean $\bar{x}$, sample standard deviation s, sample proportion $\bar{p}$, etc. The value of the stat is used to estimate the value of the corresponding population parameter. **Sampling distribution:** a probability distribution consisting of all possible values of a sample statistic. **Point estimator:** The sample statistic that provides the point estimate of the population parameter. We refer to the sample mean as the point estimator of the population mean, the sample standard deviation s as the point estimator of the population standard deviation and the sample proportion as the point estimator of the population proportion p. The numerical value obtained is called the point estimate. **μ** = population mean. **Central Limit Theorem:** in selecting random samples of size n from a population the sampling distribution of the sample mean $\bar{x}$ or proportion $\bar{p}$ can be approximated by a normal distribution as sample size become large (typically n ≥ 30). **Recall** $\bar{p} = x/n$, x=# of elements of interest in the sample, n=sample size, N=population. **Sampling Distribution of $\bar{p}$:** the probability distribution of all the possible values of the sample proportion, $\bar{p}$.

Expected Value of $\bar{p}$	Standard Deviation of $\bar{x}$ (Standard Error)	Standard Deviation of $\bar{x}$ (Standard Error)	Standard Deviation of $\bar{p}$ (Standard Error)	Standard Deviation of $\bar{p}$ (Standard Error)
$E(\bar{p}) = p$	*Finite Population*	*Infinite Population*	*Finite Population*	*Infinite Population*
Expected Value of $\bar{x}$ $E(\bar{x}) = \mu$	$\sigma_{\bar{x}} = \sqrt{\frac{N-n}{N-1}}\left(\frac{\sigma}{\sqrt{n}}\right)$ Use when n/N > .05	$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$	$\sigma_{\bar{p}} = \sqrt{\frac{N-n}{N-1}}\sqrt{\frac{p(1-p)}{n}}$ Use when n/N > .05	$\sigma_{\bar{p}} = \sqrt{\frac{p(1-p)}{n}}$

Interval Estimate (aka Confidence Interval): an estimate of a population parameter that provides an interval believed to contain the value of the parameter. **Margin of Error:** the ± value added and subtracted from a point estimate to develop an interval estimate. **Interval Estimate, General Form: Point Estimate ±** Confidence Coeff. * Std Error [together = Margin of Error]. **Sigma σ Known:** historical data or other info provide a good value for the population standard deviation prior to sampling. **Confidence level:** if an interval estimation procedure provides intervals such that 95% of the intervals formed using the procedure will include the population parameter, the interval is said to be constructed with 95% confidence. **Confidence Coefficient:** the confidence level expressed as a decimal. **Level of Significance:** the probability that an interval estimate will generate an interval that does *not* contain the population parameter. **Alpha** α = 1 – Confidence Coeff. **Sigma** σ **Unknown:** the more common case when no good basis exists for estimating the population standard deviation prior to taking the sample. **T-distribution:** a family of probability distributions that can be used to say things about a population mean whenever population standard deviation is unknown. **Degrees of Freedom:** a parameter of the t-distribution based on sample size n. df = n – 1. **Converting to Standard Normal Random Variable:** Z = (x – Mean) / Std Dev Lookup z score in Prob table. Resulting value is the probability.

Interval Estimate of a Population Mean: σ **Known**

$$\bar{x} \pm z_{\alpha/2}\frac{\sigma}{\sqrt{n}}$$

Values for Common Confidence Levels

Confidence Level	α	$\alpha/2$	$z_{\alpha/2}$
90%	.10	.05	1.645
95%	.05	.025	1.960
99%	.01	.005	2.576

Interval Estimate of a Population Proportion

$$\bar{p} \pm z_{\alpha/2}\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

Interval Estimate of a Population Mean: σ **Unknown**

$$\bar{x} \pm t_{\alpha/2}\frac{s}{\sqrt{n}}$$

Steps of Hypothesis Testing:

Step 1: Develop the null and alternate hypothesis	
Step 2: Specify the level of significance (α)	
Step 3: Collect the sample data and compute the value of the test statistic	
p-Value Approach	
Step 4: Use the test statistic to compute the p-value	
Step 5: Reject H_0 if the p-value $\leq \alpha$	
Step 6: Interpret the statistical conclusion in the context of the application	

Hypothesis Test: a statistical argument to show evidence of a theory about a population using sample data. Five parts:
1. **Hypotheses**: H_0: null hypothesis, opposite of the alternative. H_a: alternative hypothesis, what we are trying to prove.
2. **Test Statistic**: a formula that we plug our sample data into and get out one number.
3. **p Value**: a probability
4. **Rejection Rule**: Reject H_0 if p value ≤ α (significance level)
5. **Conclusion**: Reject H_0, we can conclude H_a. **OR** Do not reject H_0, we cannot conclude H_a.

Type I Error: the error of rejecting H_0 when it is true. **Type II Error:** the error of not rejecting H_0 when it is false.
Level of Significance: tolerance for a Type I error. Often set at alpha α = .05

Summary of Hypothesis test about a Mean: σ Known

	Lower Tail Test	Upper Tail Test	Two Tailed Test
Hypothesis:	$H_0: \mu \geq \mu_0$ $H_a: \mu < \mu_0$	$H_0: \mu \leq \mu_0$ $H_0: \mu > \mu_0$	$H_0: \mu = \mu_0$ $H_0: \mu \neq \mu_0$
Test Statistic:	$z = \frac{\bar{x} - \mu_0}{\sigma/\sqrt{n}}$	$z = \frac{\bar{x} - \mu_0}{\sigma/\sqrt{n}}$	$z = \frac{\bar{x} - \mu_0}{\sigma/\sqrt{n}}$
p-value Approach: p-value	$P(Z < z)$	$1 - P(Z < z)$	$2P(Z < z)$ or $2(1 - P(Z < z))$ whichever is smaller
Rejection Rule	Reject H_0 if p-value $\leq \alpha$	Reject H_0 if p-value $\leq \alpha$	Reject H_0 if p-value $\leq \alpha$

Summary of Hypothesis Tests about a Population Mean: **Sigma σ Unknown**

	Lower Tail Test	Upper Tail Test	Two Tailed Test
Hypothesis:	$H_0: \mu \geq \mu_0$ $H_a: \mu < \mu_0$	$H_0: \mu \leq \mu_0$ $H_0: \mu > \mu_0$	$H_0: \mu = \mu_0$ $H_0: \mu \neq \mu_0$
Test Statistic:	$t = \frac{\bar{x} - \mu_0}{s/\sqrt{n}}$ With n-1 df	$t = \frac{\bar{x} - \mu_0}{s/\sqrt{n}}$ With n-1 df	$t = \frac{\bar{x} - \mu_0}{s/\sqrt{n}}$ With n-1 df
p-value Approach: p-value	$P(T > t)$	$P(T > t)$	$2P(T > t)$
Rejection Rule	Reject H_0 if p-value $\leq \alpha$	Reject H_0 if p-value $\leq \alpha$	Reject H_0 if p-value $\leq \alpha$

Summary of Hypothesis Tests About a Population Proportion

	Lower Tail Test	Upper Tail Test	Two-Tailed Test
Hypotheses	$H_0: p \geq p_0$ $H_\mathrm{a}: p < p_0$	$H_0: p \leq p_0$ $H_\mathrm{a}: p > p_0$	$H_0: p = p_0$ $H_\mathrm{a}: p \neq p_0$
Test Statistic	$z = \frac{\overline{p} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$	$z = \frac{\overline{p} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$	$z = \frac{\overline{p} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$
Rejection Rule: *p*-Value Approach	Reject H_0 if p-value $\leq \alpha$	Reject H_0 if p-value $\leq \alpha$	Reject H_0 if p-value $\leq \alpha$